Sneak Preview of the Saskatchewan Soil Information System (SKSIS)

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What is SKSIS?

- SKSIS: new initiative underway since Jan. 2016
  - *Storing*: Repository for survey and other data
  - *Accessing*: Platforms (desktop and mobile)
  - *Refining*: Digital soil mapping (DSM)
  - *Sharing*: User-uploaded soil data (crowdsourcing)
  - *Using*: Nutrient management app (just one example)

Start where you are, use what you have, do what you can. – Arthur Ashe

Why is it so important right now?

- For the past 20 years, CanSIS resources have diminished, but soil data demand has grown
- Provincial databases faced similar cuts or were never developed: expected CanSIS would continue to deliver all soil information
- Although the government sector has now stabilized (at new lower capacity – for the moment?), soils-related work in other sectors continues to grow

Data needs

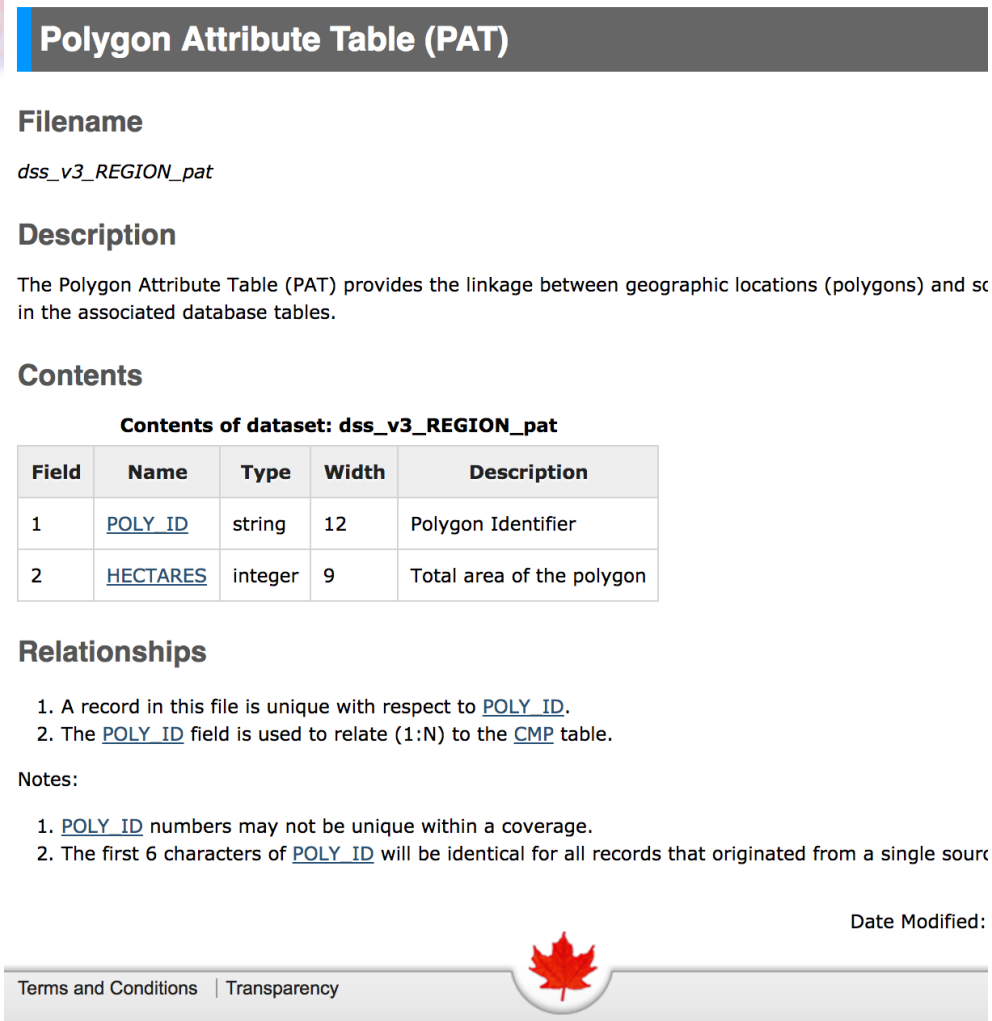
- Decentralization of soils expertise has created a gap in soil information management, but…
- Also creates an *opportunity* to build an innovative data management platform that:
  - Provides ease-of-access to legacy soil survey data
  - Integrates legacy data with *new data* (soil and environmental) collected across all sectors
  - Integrates *new types* of soil data and environmental covariates with existing survey data

Storing soil information

- Regardless of government priorities, need to ensure that legacy data collected throughout the 20th century are stored securely

Accessing soil information

- Although data have been in GIS format for years, these data have not always been in a format that's readily accessible to the every-day users
- Paper surveys still available, but harder to mine for patterns, etc.



Polygon Attribute Table (PAT)

Filename

dss_v3_REGION_pat

Description

The Polygon Attribute Table (PAT) provides the linkage between geographic locations (polygons) and sc
in the associated database tables.

Contents

Contents of dataset: dss_v3_REGION_pat

Field	Name	Type	Width	Description
1	POLY_ID	string	12	Polygon Identifier
2	HECTARES	integer	9	Total area of the polygon

Relationships

1. A record in this file is unique with respect to POLY_ID.
2. The POLY_ID field is used to relate (1:N) to the CMP table.

Notes:

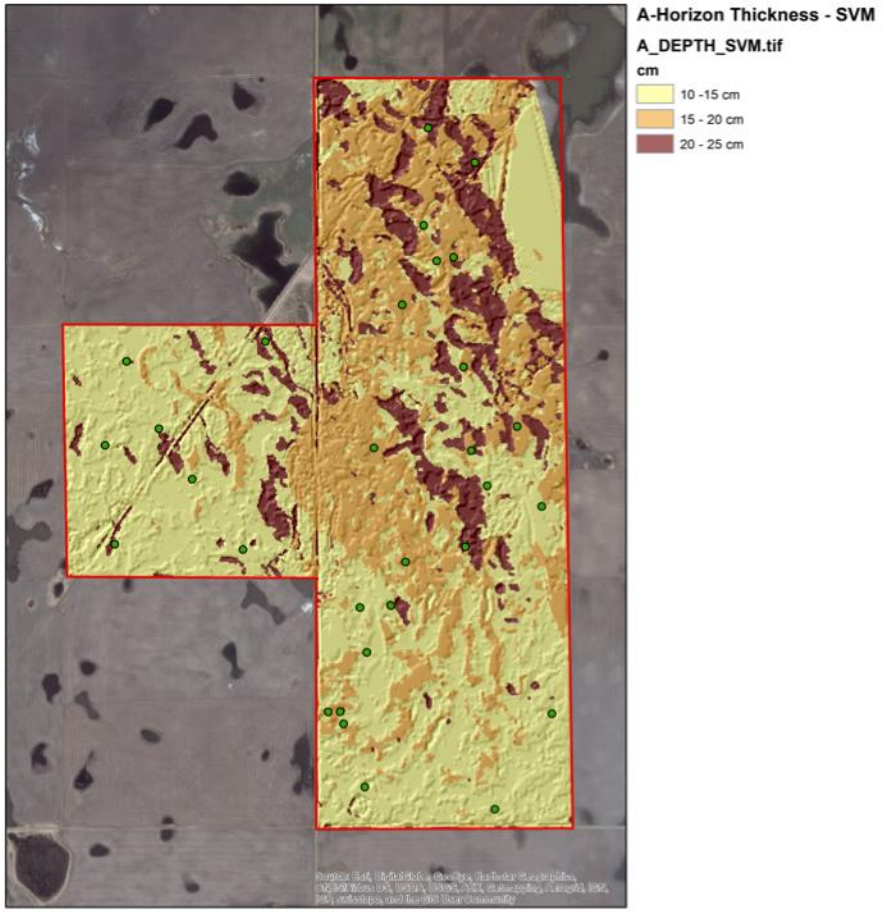
1. POLY_ID numbers may not be unique within a coverage.
2. The first 6 characters of POLY_ID will be identical for all records that originated from a single sourc

Date Modified:

Terms and Conditions | Transparency

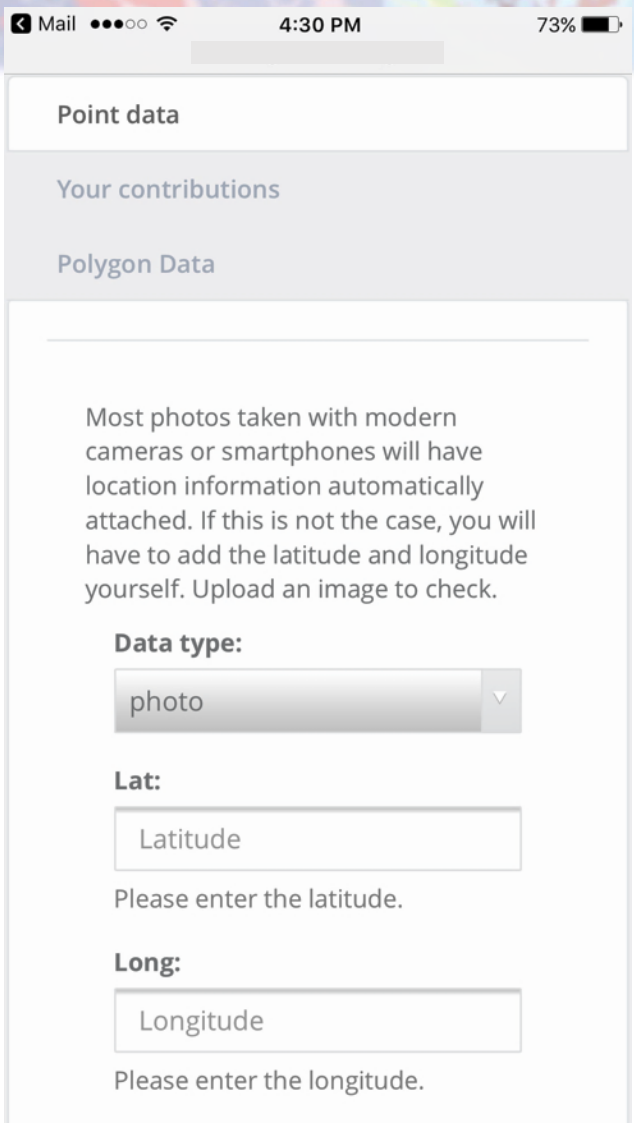
Refining soil information

- Existing soil information for Saskatchewan is mostly at the 1:100,000 scale (1 cm on the map = 1 km on the ground) – too coarse for many applications
- New techniques allow us to refine maps without full re-survey



Sharing new soil information

- With the decentralization of soils enthusiasts, more opportunity than ever to expand our soil database through data sharing: “crowdsourcing”
- Also have the opportunity to broaden the type(s) of info
- Many hands (smartphones?) make light work!



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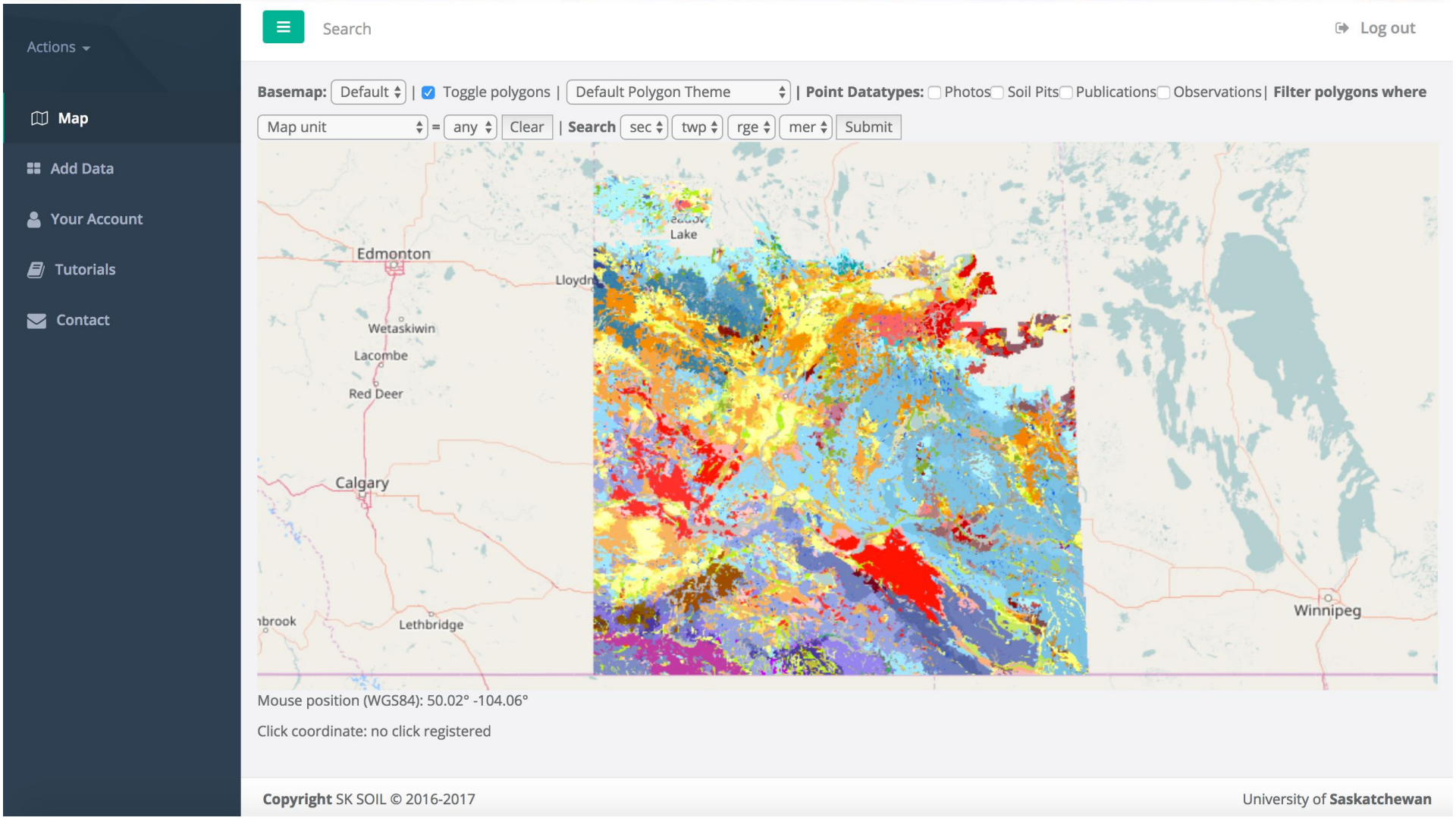
Using soil information

- Planning
  - Use soil data to inform cropping decisions
  - Integration with new applications (apps) for planning
- Purchasing
  - Better idea of what lies beyond the fence
- Precision management
  - Integrate enhanced soil data with yield data to develop nutrient management plans

Using soil information

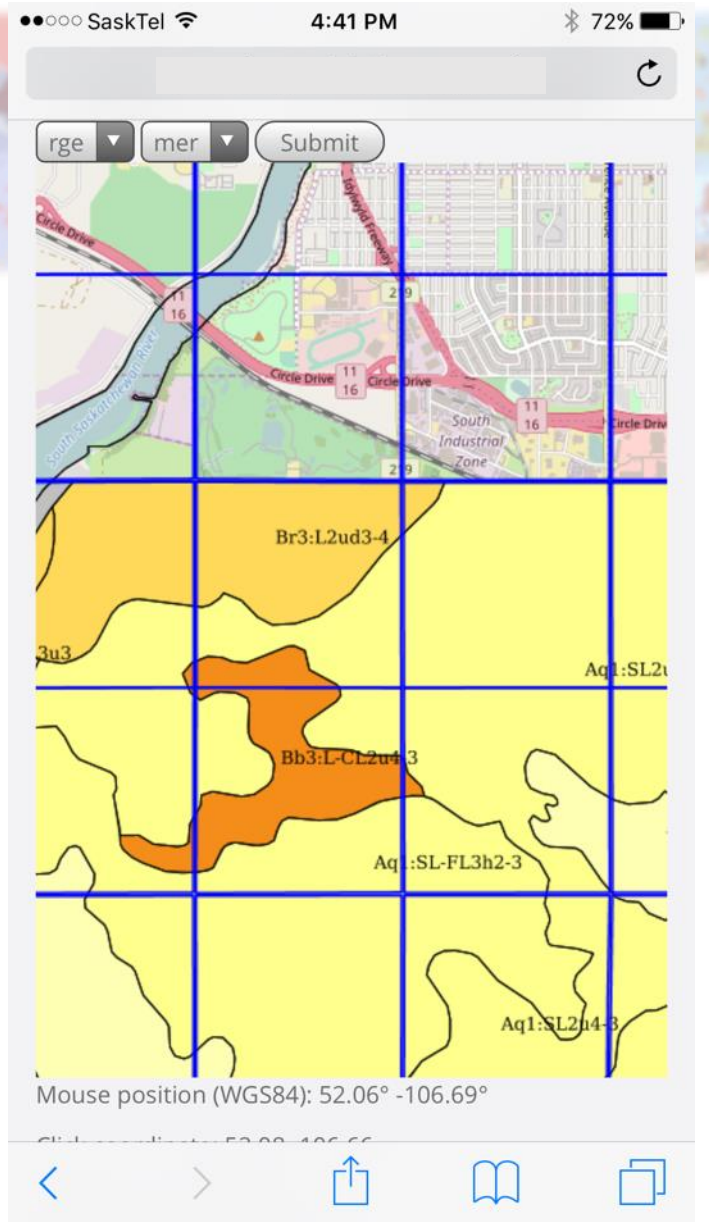
- Education
  - K-12, post-secondary, and beyond
- Research
  - Site selection, scaling up, modeling
- Planning
  - Land use, environmental assessment
- Policy
  - Food and water security, climate change

Sneak preview: access



Mobile data access

- Interface is built via mobile responsive web design so that it can be easily viewed both desktop and mobile applications
- Working on option to ask “What soil is right here?”
- System designed for rapid download in the field and on-the-fly query (GeoWeb cache)



Refinement via digital soil mapping

- To get data from 1:100,000 (1 cm = 1 km) to 1:10,000 (1 cm = 100 m) or better, we can use modern digital soil mapping (DSM) methods
- DSM allows us to:
  - Refine maps from associations to individual soil types
  - Refine soil property maps to reflect landscape scale
  - Better predict landscape-scale variability for management planning and predictive modeling

What is digital soil mapping?

- "…the creation and population of spatial soil information systems by numerical models inferring the spatial and temporal variations of soil types and soil properties from soil observation and knowledge and from related environmental variables…" – Lagacherie and McBratney 2007

- Simply: making soil maps based on GIS data layers (vs. digitizing existing soil maps)

Digital soil mapping (DSM): How?

- SKSIS project is testing DSM methods at three SK sites: Schoenau (Central Butte), Western Sales (Rosetown), Nerbas (Waseca)
- Use combination of DEM, legacy data, expert knowledge to refine soil maps from 1:100,000 down to 1:10,000 or better
  - Explore knowledge-based and machine-learning based methods
  - Build on previous projects (e.g., wetland soil mapping project, LWBSF)
  - Ideal approach may require a combination!

Two main approaches

Knowledge driven

- Uses conceptual soil landscape model to predict soils
  - More subjective
  - Tacit knowledge
- Combine DEM attributes, landform classification, and expert knowledge

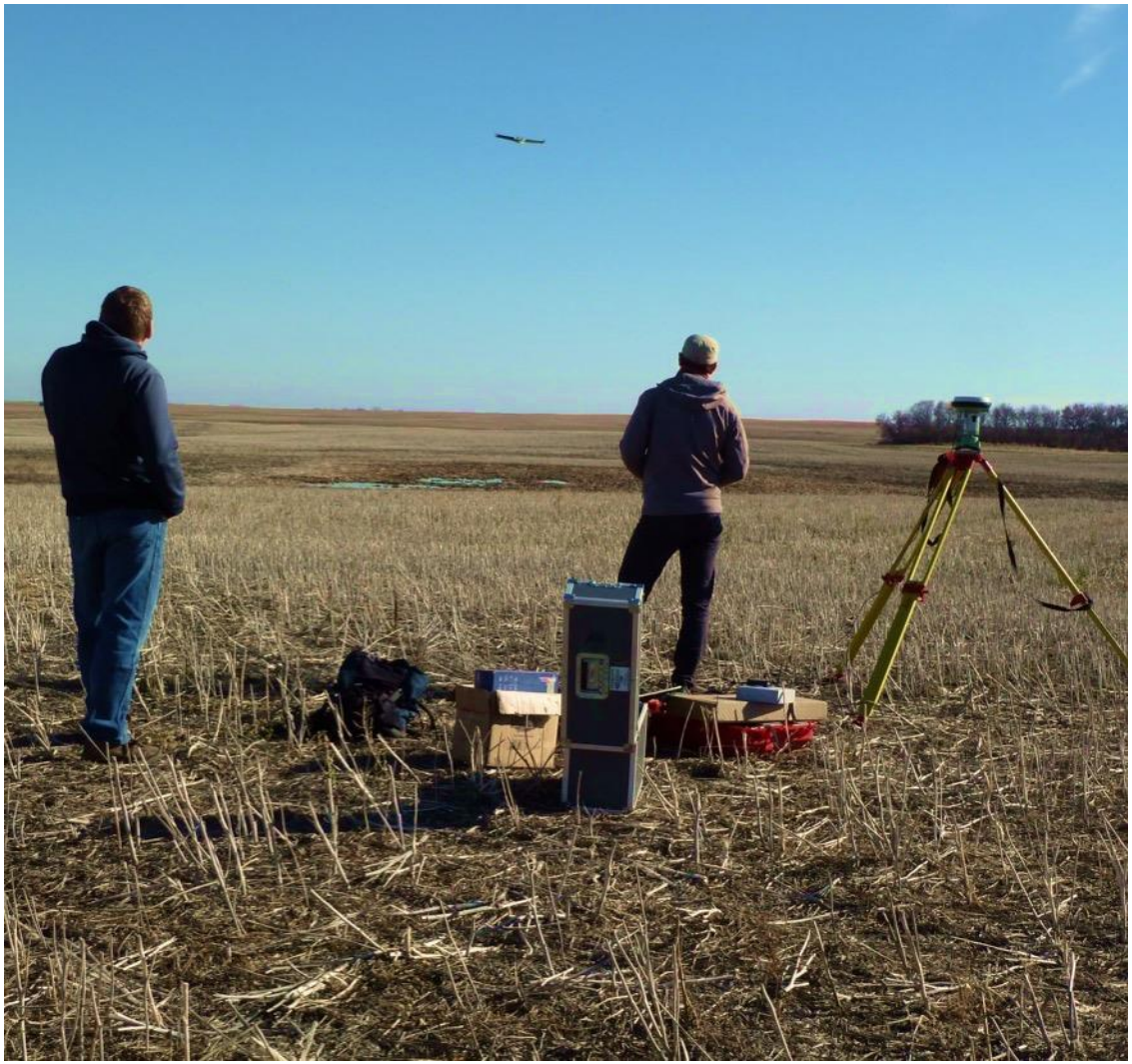
Data driven

- Pedometric approaches
  - More objective
- "Machine learning"
  - Give the computer lots of example soils and let it go!
- Regression, correlation trees, random forest to identify patterns

Digital soil mapping: Inputs

- Need:
  - High-resolution DEM (LiDAR, drone-based)
  - In-field point observations (for prediction and for validation)
  - Other covariate data
- Ideal:
  - Collaboration between DSM experts and those collecting lots of point observations!

Digital soil mapping: Inputs

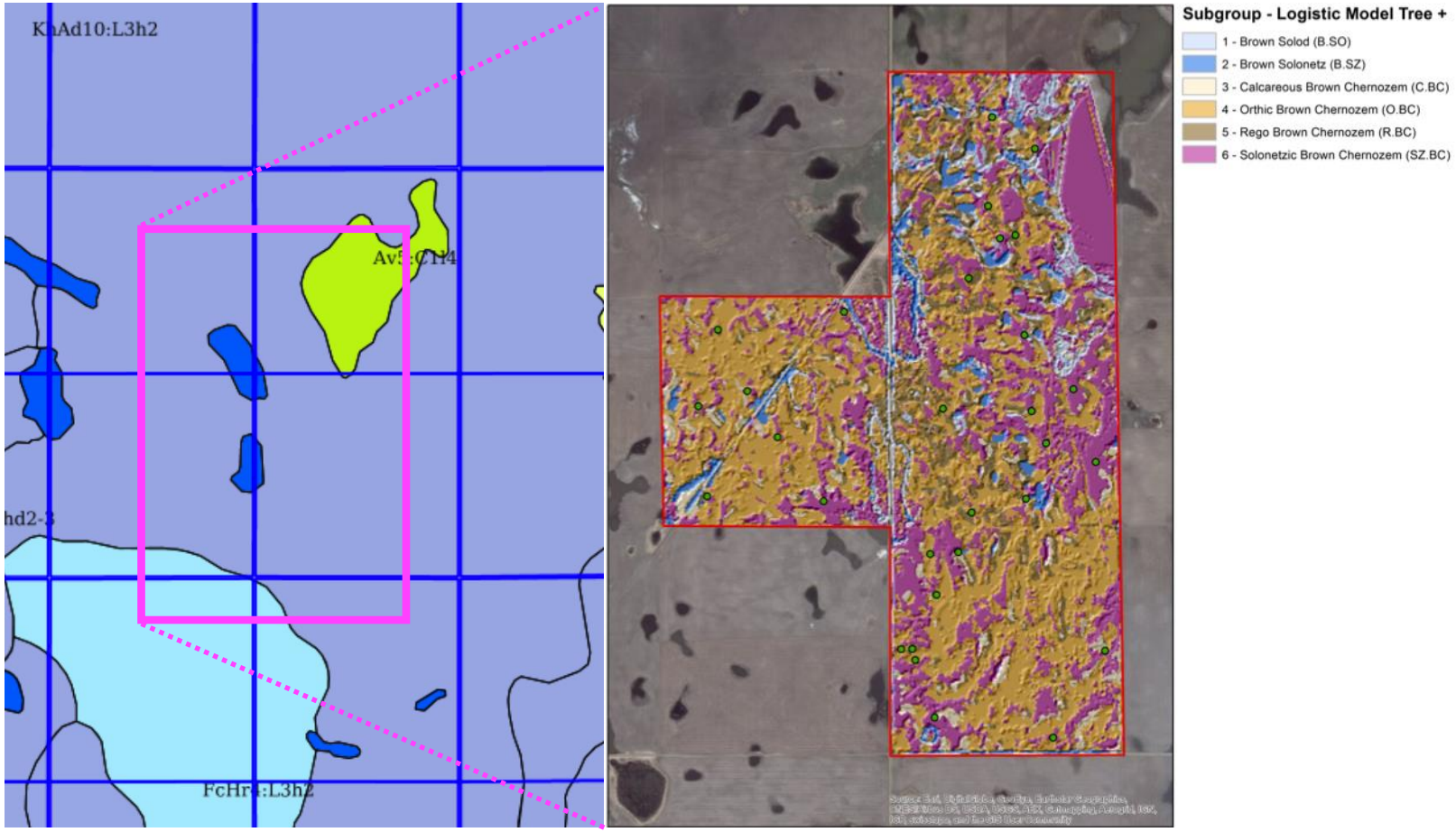


Digital soil mapping: Inputs

- Aspect
- Curvature
- Elevation
- LS-factor
- Slope position (x2)
- MRVBF
- Plan curvature
- Profile curvature
- Skyview factor (x2)
- Slope
- Wetness index (x2)
- Tangent curvature

15 environmental covariates, 8 principle components

DSM outputs: preliminary



Digital soil mapping: potential…

- Initial focus will be on refining soil types
- As we build our point dataset, will have more covariates available for machine-learning techniques to expand predictive mapping of soil properties
  - Soil organic matter
  - Nutrients
  - A-horizon thickness
  - Etc…

Can citizen science assist digital soil mapping?

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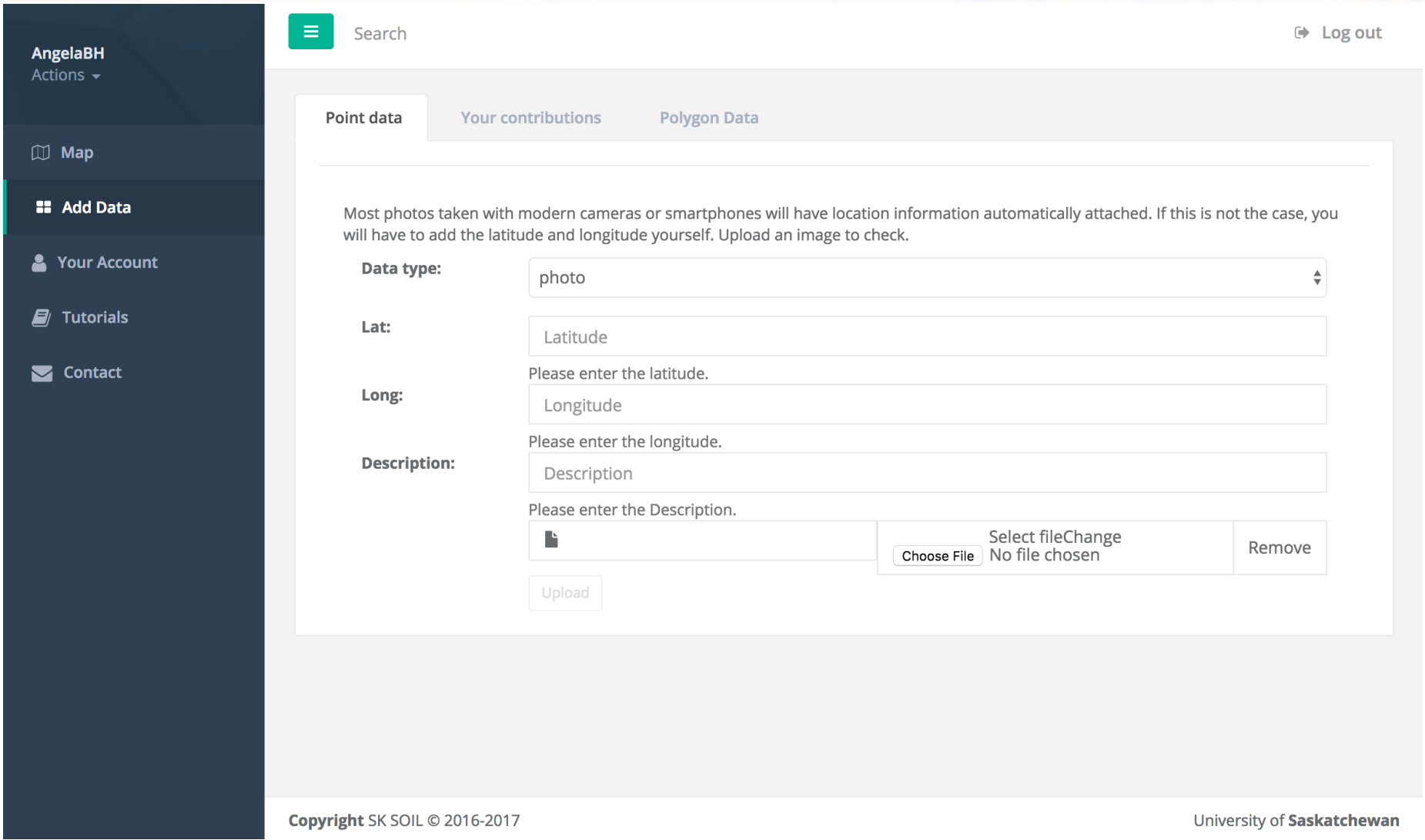
A B S T R A C T

The essential element of citizen science is the participation of non-specialists in scientific research. The citizen acts as an observer or experimenter within structures established by a project run by professional scientists. The recent explosion in projects is due to the development of enabling technology, exemplified by the spatially-enabled "smart" phone with mapping applications and its supporting networks including the GPS system. Citizen science projects have two purposes: (1) to amplify scientific research; and (2) to build citizen support for, and understanding of, science. Current initiatives in citizen soil science include the OPAL Soil and Earthworm Survey, GLOBE, and mySoil, but these are not aimed at soil mapping. We propose digital soil mapping (DSM) citizen science initiatives for countries with and without well-organized extension and advisory services and existing soil surveys, and identify types of citizens who might be motivated to contribute to such initiatives. Contributions could be in the form of tacit knowledge, opportunistic or protocol-guided new information, information from precision agriculture, and physical samples submitted for analysis. The primary beneficiary of such projects would be the professional mapper using digital information to produce or enhance maps of soil properties or types. The secondary beneficiary would be the citizen scientist, who would benefit from an enhanced map, and may be better able to participate in policy debates related to the soil resource. In addition, participation would enhance the connectivity between the soil resource and the citizen.

Sharing new soil information

- Since the original soil surveys were carried out, new technologies have emerged
  - Analytical techniques
  - Remote sensing
  - Proximal sensing
  - Data capture and analysis – Including producer data!
- Decentralization means these data are being collected by many individuals, but there are opportunities created by bringing it together!

Sneak preview: sharing



Obstacles to effective sharing

- Privacy
- Competition

From Rossiter et al. (2015):

- Developing protocols for data upload and sharing
- Quality control and data evaluation
- Integrating data of variable types, irregular spatial distribution – and variable quality
- Quantifying uncertainty

Next steps: 2017

- Finish in-house testing of key features, including integration with smartphones
- Field-testing of beta version
- Validation and refinement of DSM methods across all three test sites
- Develop application that uses soil data to inform management decisions
- Identify top priorities for next phase of project

Next steps: 2018 and beyond…

- Develop data sharing protocol and policy
- Expand user-uploaded data utilities
- Systematize the DSM process
- Revisions and updates to reflect new technology
- Tech/knowledge transfer: get more people involved

Continue to build a user-friendly, online community of SK soil enthusiasts, creating more opportunity for all!

Acknowledgments

COLLABORATORS

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  - Western Sales
- Jeff Schoenau
- Tim Nerbas
- Henry de Gooijer
- Darwin Anderson
- Brian McConkey

FUNDERS

Saskatchewan
GOVERNMENT OF SASKATCHEWAN

SaskCanola
Saskatchewan Canola Development Commission

SASKATCHEWAN pulse Growers

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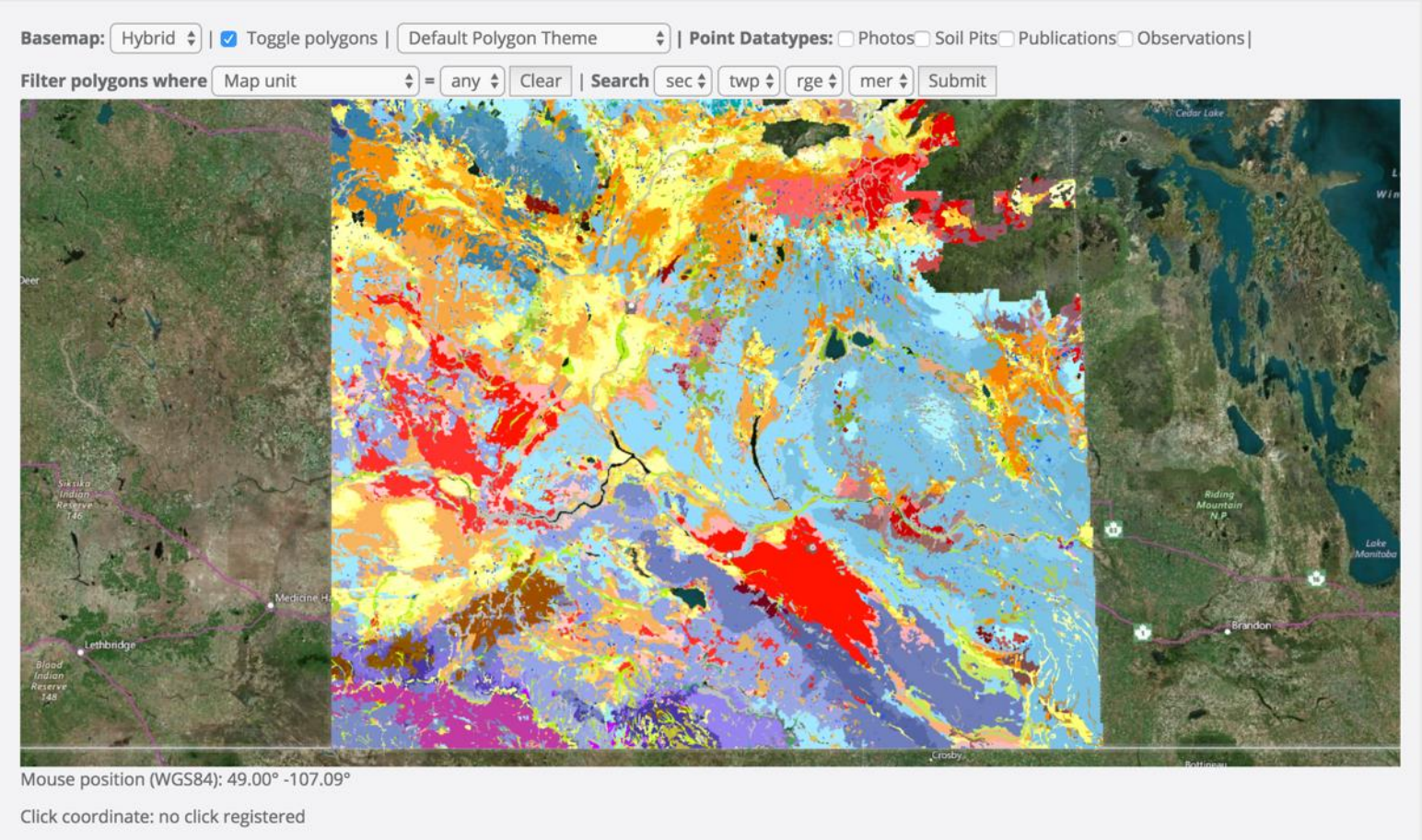

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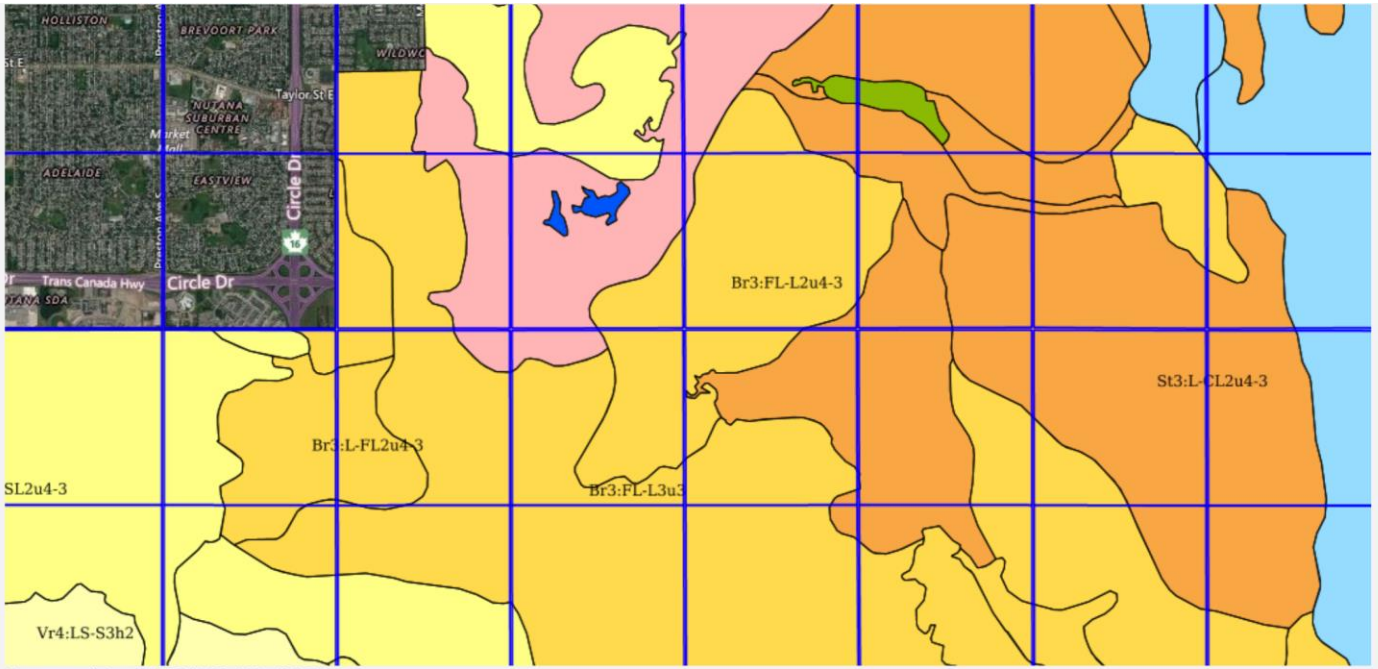


Mouse position (WGS84): 52.11° -106.64°

Click coordinate: 52.09 -106.57

Polygon ID: SKDSSSAA0569

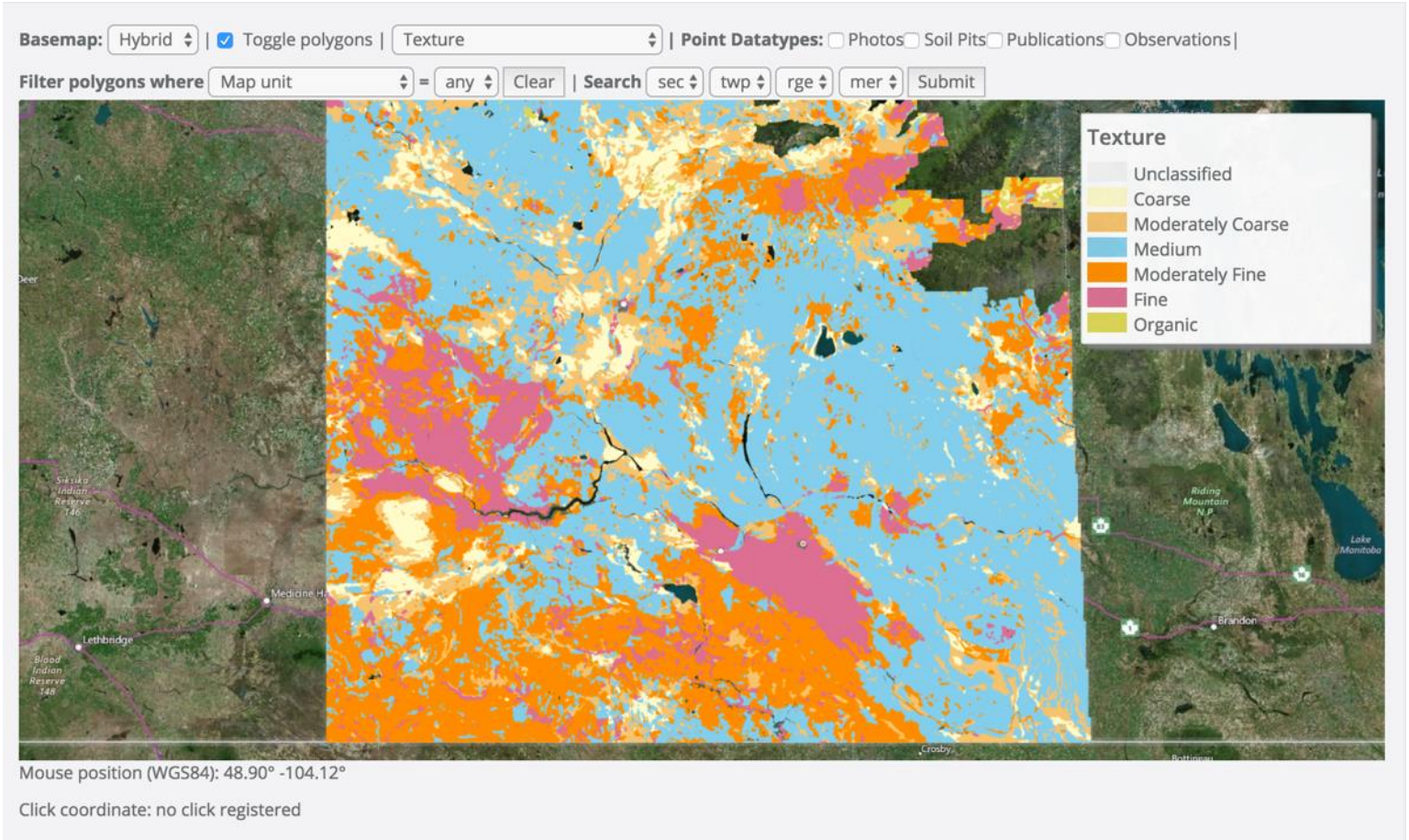
Surface Expression: UNDULATING (u)

Slope Description: GENTLE SLOPES 2 - 5% (CLASS 3)

Stoniness: Nonstony

Association: ELSTOW CA.DBC

Sneak preview: access



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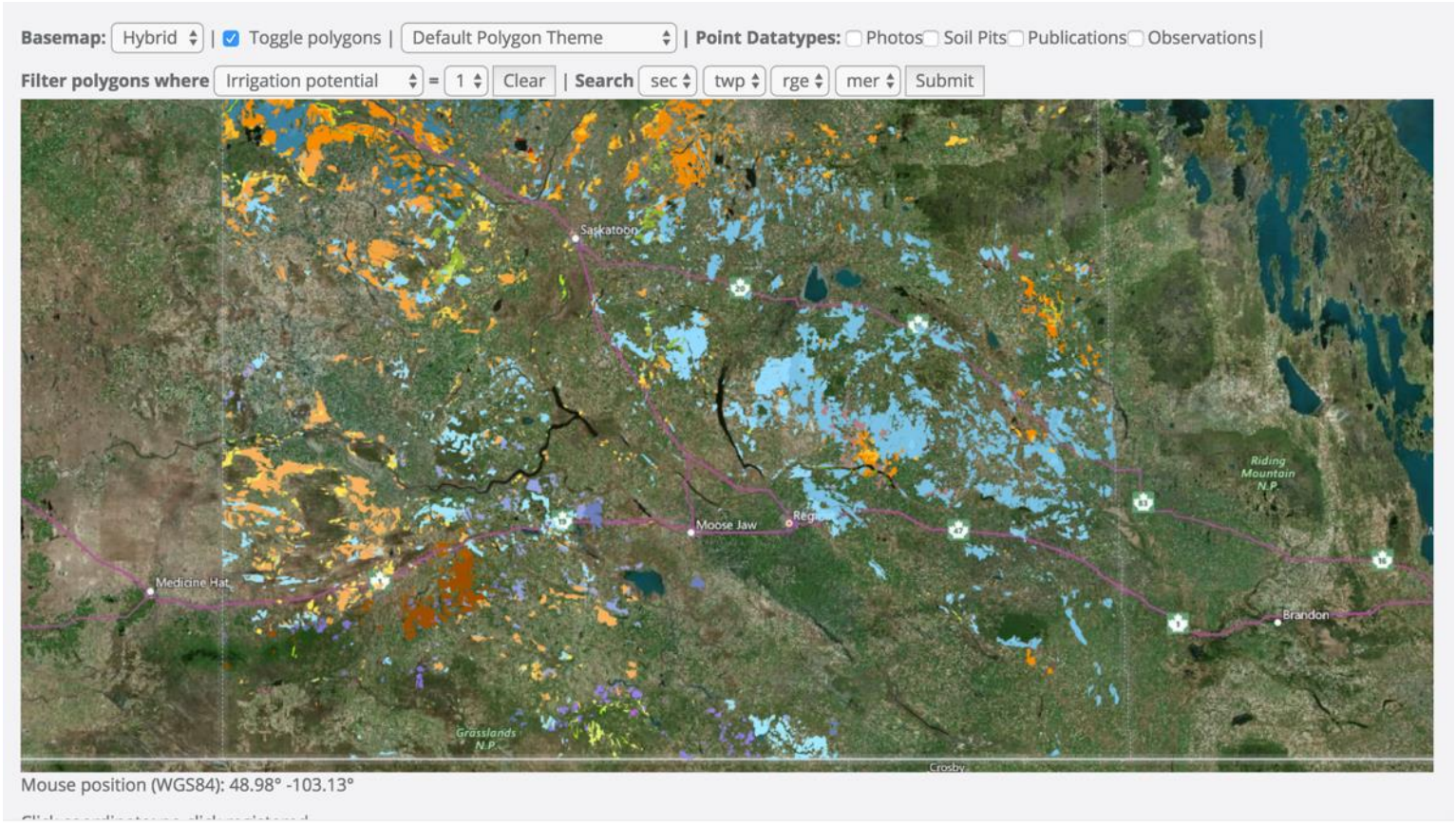

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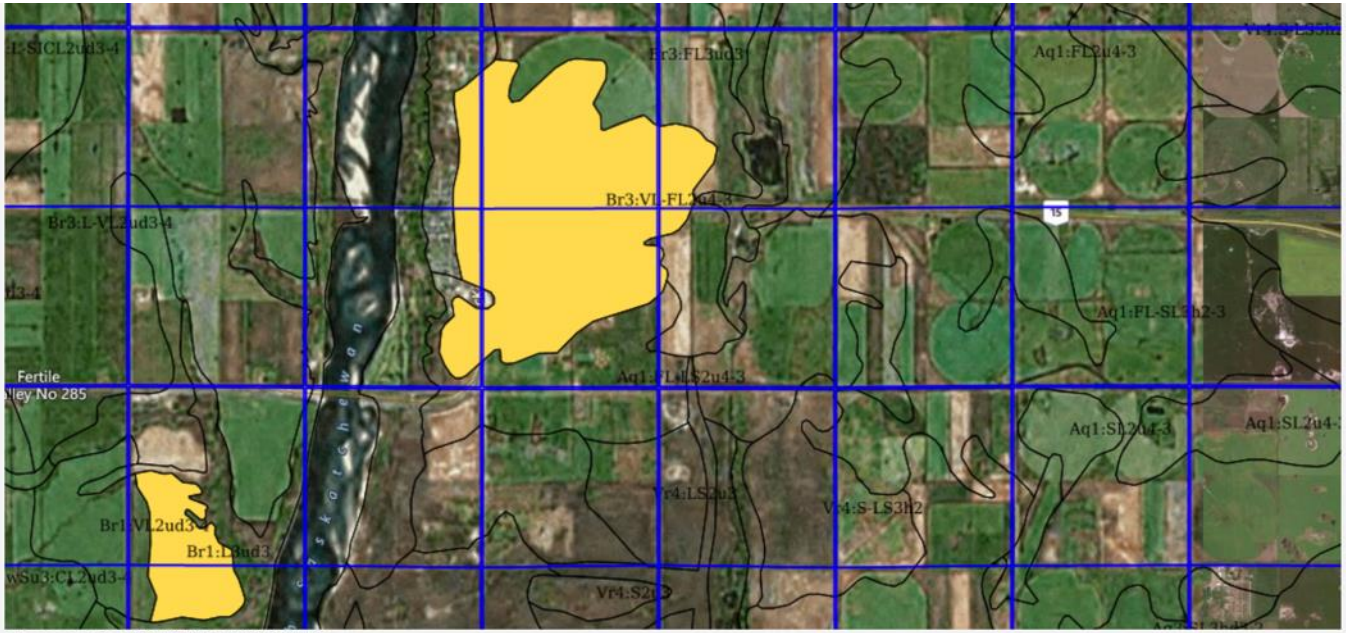

Mouse position (WGS84): 51.48° -107.07°

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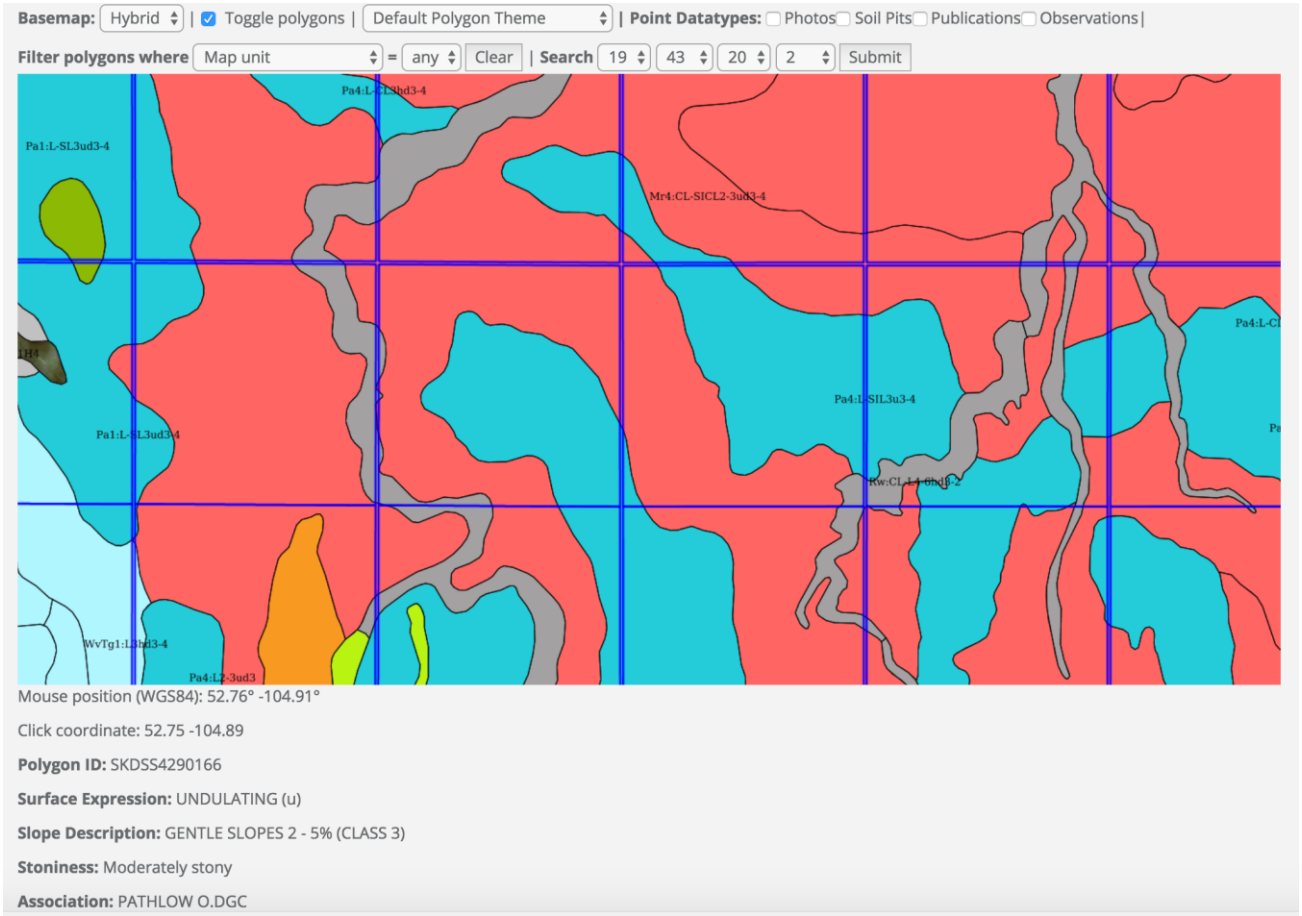
Surface Expression: UNDULATING (u)

Slope Description: VERY GENTLE SLOPES 0.5 - 2% (CLASS 2)

Stoniness: Nonstony

Association: BRADWELL E.DBC

Sneak preview: access



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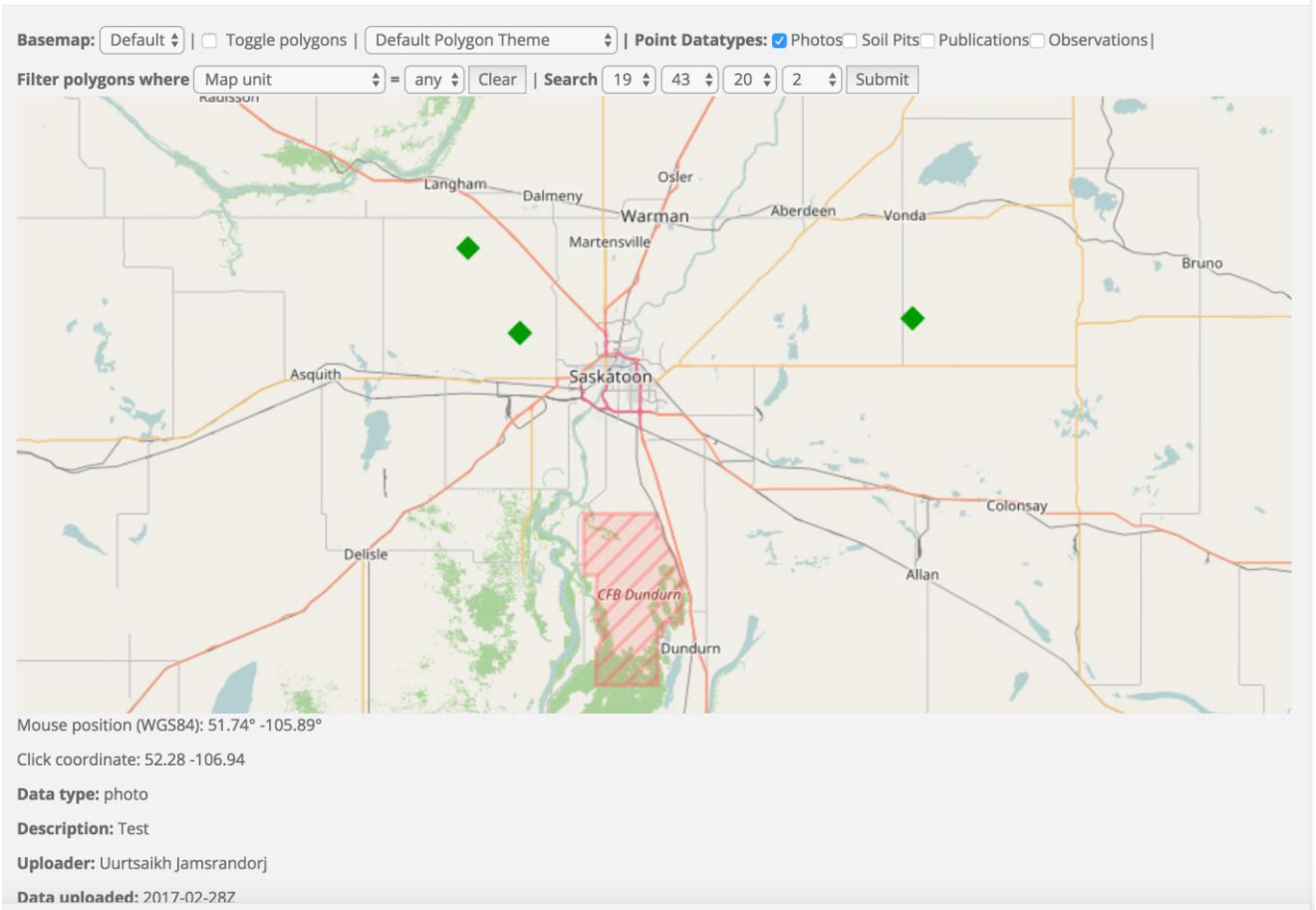

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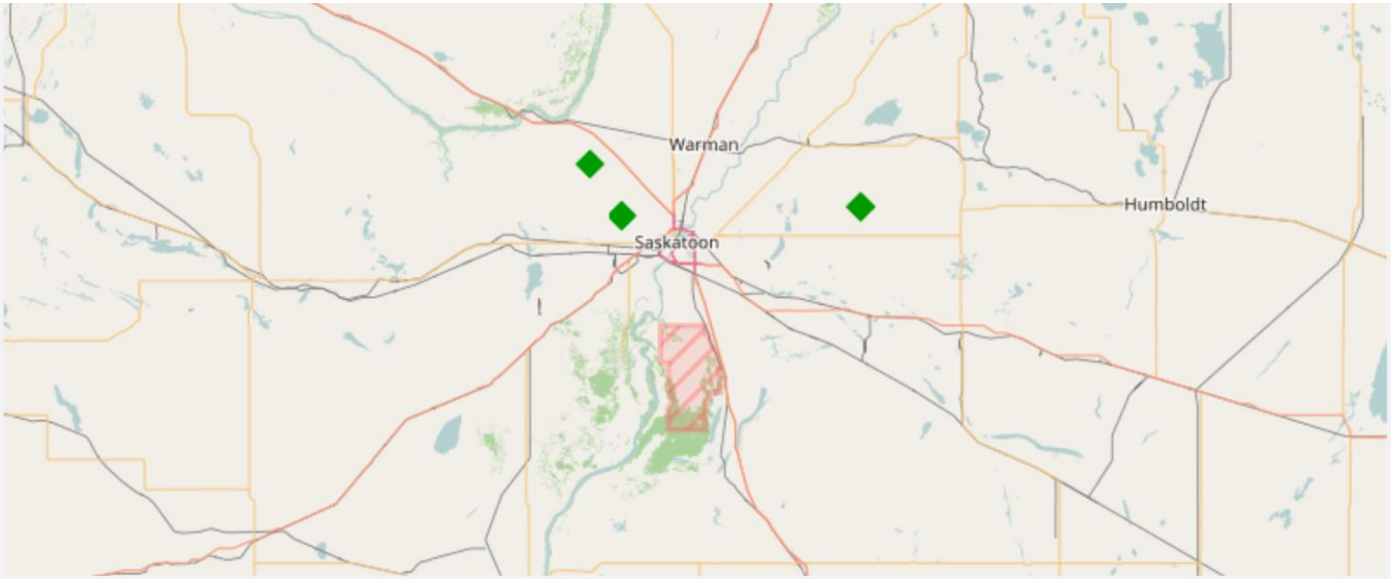


Mouse position (WGS84): 52.55° -108.78°

Click coordinate: 52.17 -106.83

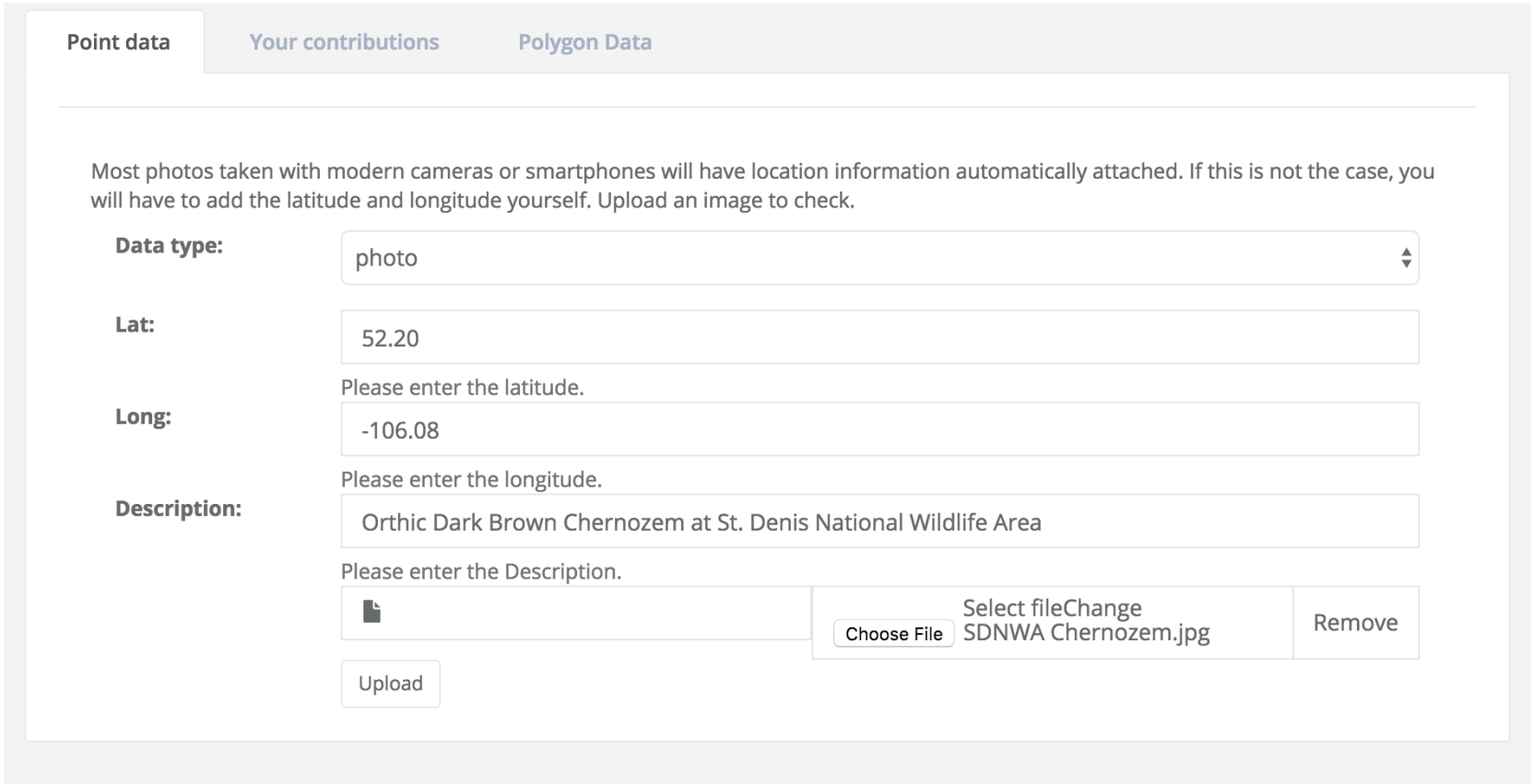
Data type: photo

Description: B horizon exposure during pipeline integrity dig west of Saskatoon, SK

Uploader: kent.walters@usask.ca

Data uploaded: 2017-02-14Z

Sneak preview: sharing



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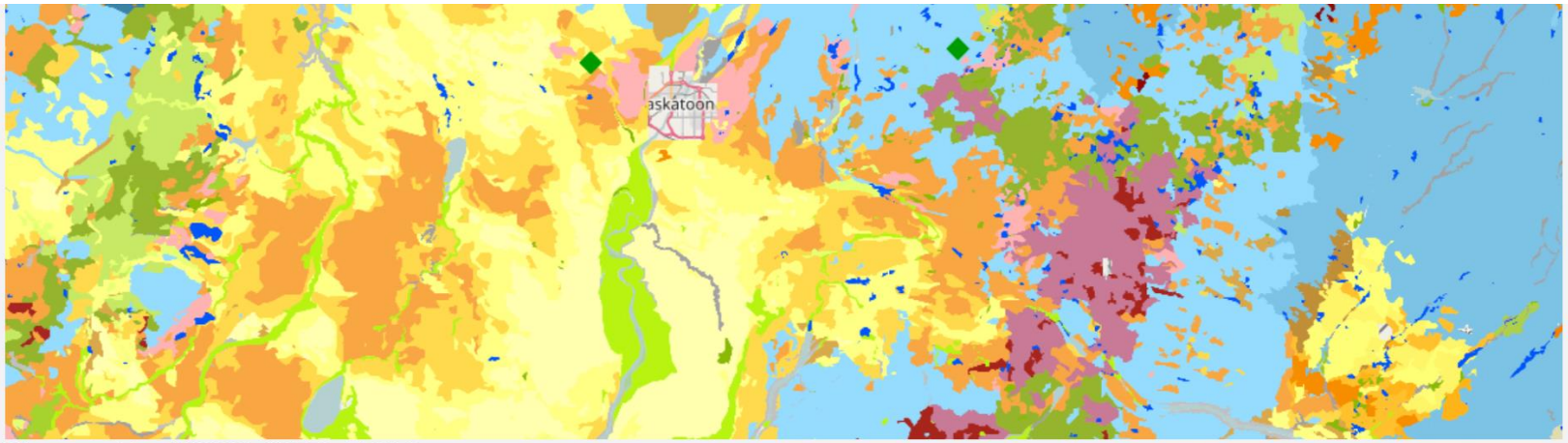
Sneak preview: sharing

Point data | **Your contributions** | Polygon Data

Upload Date	Description	Datatype	Coordinats
2017-03-05	Orthic Dark Brown Chernozem at St. Denis National Wildlife Area	photo	{"type":"Point","coordinates": [-106.08,52.2]}

Sneak preview: sharing



Mouse position (WGS84): 51.75° -106.24°

Click coordinate: 52.20 -106.12

Data type: photo

Description: Orthic Dark Brown Chernozem at St. Denis National Wildlife Area

Uploader: AngelaBH

Data uploaded: 2017-03-05Z

Sneak preview: sharing